GRADING CHARACTERISTICS OF KANSAS HONEYS

by

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INTRODUCTION

The beekeeping industry began in Kansas about 80 years ago according to Parker (1943). In 1946 there were 60,000 colonies of honeybees which yielded 3,360,000 pounds of honey and in 1947 there were 64,000 colonies of honeybees which yielded 2,650,000 pounds of honey in the state (Smith et al., 1948). The marketing quality of this honey is influenced by the source of the nectar from which the honey was made, the climatic conditions, soil and other environmental factors which influence the growth of the plants and the treatment given the honey after it is removed from the hive (Phillips, 1928).

As can be seen from a comparison of the data issued by the United States Department of Agriculture in Agricultural Statistics for 1948, nearly all of the honey produced in Kansas is in the extracted form (Smith et al., 1948). Honey to be extracted is stored in the comb by the bees, the cells of which are later uncapped with a heated knife. The honey is extracted from the comb by centrifugal force, strained or filtered, and usually stored in large tanks until the air bubbles, incorporated in the extraction process, rise to the surface. The honey is then drawn into 60 pound or five-gallon containers for the wholesale or bottling trades. Before honey is placed in retail containers, it is generally

heated to retard granulation and to facilitate any further straining that may be necessary (Root et al., 1948).

Although there is much literature concerning the physical and chemical properties of honey, no work seems to have been done on the use of these properties for the comparison of Kansas honeys with honeys from other areas as to marketing qualities. This study was undertaken to make such a comparative analysis of Kansas honeys and honeys from other areas.

United States Standards for Grades of Extracted Honey

These standards which became effective March 15, 1943 supersede the United States Grades recommended by the United States Department of Agriculture in Circular No. 24, issued December, 1927 and revised August, 1933.

> Extracted honey is honey that has been separated from the crushed or uncrushed comb by centrifugal force, gravity, straining, or other means.
>
> (a) Liquid; (b) Crystallized.
>
> Comb honey is honey contained in the cells of comb.
>
> Chunk honey is comb honey surrounded by extracted honey.

Colors of Extracted Honey

Federal inspection certificates will indicate the color of honey as determined by the Pfund color-scale instrument upon examination.

Pfund scale readings (in millimeters)

Water-white	From 1 to 8
Extra-white	From 8 to 16.5
White	From 16.5 to 34
Extra light amber	From 34 to 50
Light amber	From 50 to 85
Amber	From 85 to 114
Dark	Readings of 114 and over

Grades of Extracted Honey

U. S. GRADE A or U. S. FANCY extracted honey may be honey of any color; shall be clean; and shall be free from damage caused by turbidity, overheating, fermentation, honeydew, objectionable flavor or odor, or other means.

The honey shall be well-ripened and shall weigh not less than 11 pounds 12 ounces per gallon 231 cubic inches at 20° C. (or 68° F.). Expressed in other equivalents, extracted honey shall conform to the following:

Brix reading	Not less than 79.8 at 20° C.
Baumé reading	Not less than 42.49 at 60° F.
Refractometer index	Not less than 1.4900 at 20° C.
Specific gravity	Not less than 1.4129 at 20° C.

Honey of the crystallized type of this grade shall be uniformly granulated, smooth and fine in texture, and liquified at 130° F. shall meet all other requirements of U. S. GRADE A or U. S. FANCY.

U. S. GRADE B extracted honey may be honey of any color; shall be fairly clean; and shall be free from damage caused by turbidity, overheating, fermentation, honeydew, objectionable flavor or odor, or other means.

The honey shall be well-ripened and shall weigh not less than 11 pounds 12 ounces per gallon of 231 cubic inches at 68° F. Expressed in other equivalents, extracted honey shall conform to the following:

Brix reading	Not less than 79.8 at 20° C.
Baumé reading	Not less than 42.49 at 60° F.
Refractometer index	Not less than 1.4900 at 20° C.
Specific gravity	Not less than 1.4129 at 20° C.

Honey of the crystallized type of this grade shall be uniformly granulated, fairly smooth and medium to fine in texture, and when liquefied at 130° F. shall meet all other requirements of U. S. GRADE B.

OFF-GRADE extracted honey is honey that fails to meet the requirements of U. S. GRADE B.

Explanation of Terms

The density shall be determined by Brix or Baumé hydrometer spindles, or by refractometer, read at the proper temperature for the instrument used, or by weight in a standard measure.

"Clean" means that the honey shall be at least as free from foreign material, such as wax, propolis, bees, parts of bees, or dirt, as honey that has been strained through standard bolting cloth of 86 meshes per inch at a temperature of not more than 130° F.

"Fairly clean" means that the honey shall be at least as free from foreign material as honey that has been strained through standard bolting cloth of 23 meshes per inch at a temperature of not more than 130° F.

"Damage" means any injury or defect that materially affects the appearance, edibility, or shipping quality of the honey.

"Serious damage" means any injury or defect that seriously affects the edibility or shipping quality of the honey.

"Turbidity" means cloudiness caused by pollen grains, minute air bubbles, finely divided wax particles, or other substances that detract from the clearness of the honey.

"Objectionable flavor or odor" means any flavor or odor from a floral source, taint of smoke, or other source, that materially affect the edibility of the honey. Nectar gathered from plants such as bittersweet often imparts to the honey a very disagreeable flavor which materially injures its quality. (Abstracted from Root et al., 1948).

Principal Honeys Produced in Kansas

Due to the diverse floral origins of nectar, honeys differ in color and flavor. In an area where honey is produced,

there are usually only a few plants that secrete nectar in adequate abundance to provide honeys typical of that region (Phillips, 1928). Kansas has a great variation in rainfall, altitude, soils, temperature, and other ecological factors which divides the state into four main regions with respect to the honey plants present (Merrill, 1922). There are at least 75 species of plants of sufficient importance to be listed as sources of nectar in Kansas (Lovell, 1926; Pellett, 1947; Kauffeld, 1949). Only a very small number of these such as white clover, yellow sweet clover, white sweet clover, alfalfa, smartweed, broomweed, and Spanish needle can be listed as major sources of nectar (Parker, 1950). Some of the minor plants may have importance by their influence on the quality of honey produced.

REVIEW OF LITERATURE

There is a vast literature dealing with the chemical and physical properties of honey. Wiley (1892) gave the analysis of several American honeys. Browne (1908) recorded probably the most exhaustive study of American honeys. Bryan (1911) published results of examinations of imported honeys from Cuba, Mexico, and Haiti. Nearly all of these dealt to a large extent with the chemical properties of honeys and the detection of adulteration in honey. Van Dine and Thompson (1908) reported on a comparative study of Hawaiian honeys in

relation to honeys produced on the United States mainland. Fraps (1921) gave a chemical analysis of Texas honeys. Eckert and Allinger (1939) published a study of the physical and chemical properties of honeys from 37 different plant sources as well as several blended honeys from California. Dase and Bose (1947) gave results of a study of Indian honeys in comparison to honeys from other sections of the world. Muttelet (1910), Moreau (1911) and de Boer (1948) reported on extensive studies of European honeys.

AIMS AND METHODS

Twenty samples of honey from typical floral sources from various parts of the United States and one sample from Guatemala were compared with 20 samples of honey from typical floral sources in various parts of Kansas. All samples of honey were produced in 1950.

Color

The color grading of honey depends on a study of the transmission of light through honey. All honeys absorb light in some degree, and the darker grades absorb light unequally through the color spectrum (Phillips, May, 1929).

The active principle of the Pfund color-scale instrument consists of an elongated wedge-shaped trough made of glass to receive a sample of the honey to be graded. A wedge of amber

EXPLANATION OF PLATE I

Pfund Color Grader

PLATE I


WHITE
EXTRA LIGHT AMBER
LIGHT AMBER
AMBER
COLOR GRADER
MUNSELL COLOR CO.

glass is placed inversely to the sample of honey. To find the shade of the sample of honey, the two wedges, one of honey and one of amber glass, are viewed simultaneously, through a vertical slot. The two wedges are moved back and forth until the colors exactly match at which time a reading in millimeters is taken (Root et al., 1948).

Flavor

It is rather difficult to describe or measure the flavor of honey due to the personal preferences of individuals. A scale proposed by Dodge (1929) was used in this analysis. Flavor may be said to have two characteristics: i. e., intensity and appeal. By scaling these two properties, one horizontally, the other vertically as shown on the chart, and numbering the squares thus formed, a rough graphic representation embracing the field of flavor of honey may be obtained.

By use of this scale personal preferences for the flavors of certain honeys do not influence to any marked degree the rating given a sample of honey. Those honeys receiving a flavor grade of A or B were considered to have a desirable flavor, while those honeys receiving a flavor grade of C or D were considered to have an objectionable flavor.

Honey flavor scale proposed by Dodge (1929)

Intensity		Flavor Grade			Flavor Grade	
Mild	1	A	3	9	C	11
Pronounced	2		4	10		12
Strong	5	B	7	13	D	15
Intense	6		8	14		16
Appeal	Pleasant		Neutral	Unpleasant		Rank

Cleanliness

A fifty cc sample of honey was mixed with 100 cc of water and the mixture heated to a temperature of 130° F. This sample was then passed through two filters, the first of which was standard bolting cloth of 23 meshes per inch, the second of which was standard bolting cloth of 86 meshes per inch. Honeys which passed through both filters without leaving particles of foreign matter were classed as clean, honeys which passed through the first filter without leaving particles of foreign matter, but left particles of foreign matter on the second filter were classed as fairly clean, and honeys which left particles on the first filter were classed as dirty.

Turbidity, Damage, and Foreign Matter

All samples were examined for cloudiness caused by pollen grains, minute air bubbles, finely divided wax particles, and other substances that detracted from the clearness of the honey.

Samples were examined for injury or defect that would affect the appearance, edibility, or shipping quality of the honey. Damage from smoke, carbolic acid, overheating, fermentation, and similar causes were noted and cause given. Three classifications were used under this heading--none, damage, and serious damage.

Microscopic examinations were made of all samples which tested either fairly clean or dirty to determine, insofar as possible, the origin of the foreign material. Honey containing wax or pollen particles would be preferable to honey containing bee or other insect fragments.

Acidity

Acidity was expressed in pH values as it is considered to be of more practical use to the food technologist than would acidity values expressed in per cent of formic or malic acid (Root et al., 1948). Walton (1950) recommends "that titration to pH 8.30 (corrected) measured by pH meter shall be considered equivalent to titration using phenolphtlalein indication." The pH value of honeys commonly range from pH

3.6 to pH 4.2, with extreme ranges of pH 2.4 to 4.9 (Root et al., 1948). A Beckman pH meter manufactured by the Central Scientific Company of Chicago, with temperature corrections, was used in this analysis.

Weight and Moisture

Weight per gallon and moisture content were first determined by carefully weighing one gill (118 cc) of the sample at 68° F. The measure was filled and left overnight to let the air bubbles rise to the top, more honey was added to fill the measure and the surplus smoothed off with a glass plate as recommended by Marvin (1934). The weight in grams was then multiplied by 0.07054 to obtain the weight per gallon in pounds. The number 0.07054 is obtained by dividing the number of gills per gallon by the number of grams per pound. This method was suggested by Marvin (1934).

Moisture content and weight per gallon were next determined by hydrometer readings taken at 60° F. and corrected to read at 68° F. The hydrometer used in this analysis was calibrated for liquids having a specific gravity of 1.4000 to 1.6200.

Hydrometer tests on viscous materials such as honey usually give very inaccurate results. The hydrometer appears to stick at positions other than the true equilibrium point. Chataway (1933) found the cause of this to be that when the

stem has once been wet with honey to a point above the equilibrium point, the hydrometer in rising to its true equilibrium point will be weighed down by a layer of honey clinging to the emerging portion of the stem. This can be corrected by adding a very thin film of water to the surface of the honey. As the hydrometer moves slowly near its equilibrium point, the water dissolves the adhering film of honey, keeping the stem clean.

Moisture content was next determined by the use of a Bausch & Lomb hand refractometer. It is calibrated for sucrose solutions containing from 40 to 85 per cent solids, and the scale can be read to within ±0.2 per cent at about 40 per cent solids and within ±0.1 per cent at 80 per cent solids. The refractometer is designed for use at 68° F. and has a correction thermometer attached which is calibrated in per cent sucrose according to the temperature coefficient for the refractive index of sucrose solutions (Manual for the use of the Bausch & Lomb hand refractometer). While the temperature coefficient for the refractive index of sucrose solutions differs slightly from that for honey (0.00018 and 0.00023 respectively per degree C.), Pearce and Jegard (1949) have shown that the correction thermometer on the instrument can be used with reasonable accuracy over the temperature range of 60° F. to 80° F. Pearce and Jegard (1949) also found a standard error of ±0.5 per cent for determinations by the vacuum-oven method, and of ±0.4 per cent for determinations with the Bausch & Lomb hand refractometer.

The data from all three methods used were compared by means of the Chataway table (Root et al., 1948). This table was developed to show the relationship between various hydrometer scales and refractive index to moisture content and weight per gallon of honey.

DISCUSSION OF GRADING FACTORS

In Tables 1 and 2, the various honey samples are listed as to the floral source indicated by the producer, as there was no better means of determining the floral source than the producer's label. The fact that some pollens may be identified by microscopic examination, and the fact that pollens occur in honey would appear to indicate that certain honeys could be identified by examination of pollens present. Browne (1908) disproved this theory when he found honeys from a single known floral source containing many pollens, other honeys with no pollen from the floral source, and blended honeys with no relationship shown between the quantity of each type of honey and the quantity of pollen of each type. Parker (1923) found that pollen of different plants more or less closely related were often found to be very similar or even identical in appearance, and it was frequently impossible to carry the identification as far as the species. Also, modern methods of filtering and straining of honey by the producer removes much of the pollen (Phillips, Apr., 1929).

The main use of honey color is its practical application as a clue to other characteristics, such as flavor, mineral content and any damage that may have occurred during processing and storage (Grout et al., 1949). Color and flavor are very closely associated; in general, light colored honeys are mild in flavor and dark colored honeys are pronounced in flavor.

Although Schuette and Remy (1932) indicated that there is a correlation between the mineral content of honey and its color, the darker honeys having the greater mineral content, it is generally believed that other factors are responsible for the color of honey (Grout et al., 1949). Phillips (June, 1929) states that much of the color of honey is due to plant pigment such as chlorophyll, carotenes, xanthophylls, anthocyanins and tannins. According to Lothrop and Paine (1931) the color of honey is influenced by the colloidal constiuents present in honey, the darker honeys having a higher colloidal constituent content present than lighter honeys. The color and flavor of honey from any one species of plant is subject to variation due to the ecological factors affecting the plant, such as soil, moisture, temperature, and sunlight. Also, honeys produced during a rapid nectar-flow are generally milder in flavor and lighter in color than honey produced during a slow nectar-flow (Grout et al., 1949).

Most of the factors which change the color of honey, after it has been stored by the bees, also affect its flavor. The most serious cause of discoloration and loss of flavor is

overheating (Root et al., 1948). The exact reason for the damage to honey caused by overheating is not clear, Lothrop and Paine (1931) believed that the colloids were to blame, however, Ramsey and Milum (1933) stated that it was due to a chemical reaction between the sugars and the proteins, particularly the amino acids in the honey.

Another serious cause of discoloration and loss of flavor in honey is incurred by storing honey at too high a temperature (Root et al., 1948). Lynn, Englis, and Milum (1936) found that the primary cause of darkening of honey in storage was due to the decomposition of fructose, after which the amino acids, liberated during heating or storage at high temperatures, unite with the aldehyde or ketone radical of the sugars resulting in the formation of substances which resemble caramel in color and flavor. Honey also darkens with age regardless of the storage temperature (Root et al., 1948).

A minor cause of discoloration of honey in storage and processing is due to the combination of tannates and other polyphenolic substances with iron salts from the containers to form iron tannates. Milum (1939, 1948) found that honey stored in darkness, changes to darker color more rapidly than honey stored in the sunlight.

Lynn, Englis, and Milum (1936) found that acidity had a secondary effect on the color of honey. In general those honeys with a high acid content or low pH value were lighter

in color than those honeys which had a low acid content or a high pH value.

Fermentation affects the flavor and color of honey adversely. Fermentation is brought about by the action of sugar tolerant yeasts and any method which delays their activity or destroys them entirely is of benefit. Stephen (1946) found a five-fold increase in numbers of yeast for each one per cent increase in moisture content. Therefore, only honeys with a low moisture content should be marketed, preferably 17.4 per cent moisture or less, even though honey with a moisture content of 18.6 per cent moisture may be graded as U. S. Grade A or B (Root et al., 1948). Also heating honey to a temperature of 160° F., sealing the container tightly and storing at a cool temperature has been suggested to prevent fermentation (Grout et al., 1949). Wilson and Marvin (1931) found that honey yeasts were not able to grow in honey stored at a temperature below 51.8° F.

There are many other factors which would detract from the flavor and color of honey. Taint of smoke and carbolic acid are often to blame for damage to the flavor of honey. Turbidity caused by pollen grains, minute air bubbles, finely divided wax particles, and dust often detract from the appearance of the honey. It was found by Lothrop and Paine (1931) that colloids not only cause honey to appear turbid, but also may cause it to be of a darker color. Granulation also affects

the clarity of honey. First there is a formation of dextrose crystals and increases as granulation continues. Sometimes when granulated honey is liquefied by heating, it appears turbid. This turbidity is caused by fermentation following granulation with the formation of carbon dioxide gas, the finely divided gas bubbles giving the honey the turbid appearance (Grout et al., 1949).

Occasionally honey containing visible wax particles, parts of bees, or dirt is placed on the market. This is caused by improper filtering or straining, poorly protected containers, or dirty equipment.

TABULATION OF DATA

The analytical results are tabulated and classified according to the floral source indicated by the producer. The results of analysis for damage, flavor, color, acidity, and moisture as well as U. S. Grade are given in Tables 1 and 2. Table 1 gives the results of analysis for the honeys from areas other than Kansas and Table 2 gives the results of analysis for Kansas honeys.

A summarization of the grading qualities of honeys produced in areas other than Kansas as compared to the grading qualities of Kansas honeys is given in Table 3.

Moisture content was determined by three methods--the hydrometer, weighing a known volume, and the Bausch & Lomb

Table 1. Grading qualities of 21 honeys from areas outside of Kansas.

Sample no.	Floral source	Production area	Damage Extent	Damage Cause	Flavor rating	mm	Color grade	pH value	Per cent moisture	U. S. grade
1	Alfalfa	Idaho	none		1	27	white	3.91	16.4	A
2	Alfalfa	Utah	none		3	60	lt. am.+	4.00	17.0	A
3	Alfalfa	Arizona	none		1	44	ex. lt. am.+	4.04	15.1	A
4	Alfalfa	California*	none		1	56	lt. am.	3.89	15.4	A
5	Mixed	Unknown	none		1	35	ex. lt. am.	3.80	17.4	A
6	Buckwheat	New York	none		16	130	dark	3.93	19.7	Off
7	Cotton	Unknown	none		1	26	white	3.93	16.5	A
8	Desert	Arizona	none		1	49	ex. lt. am.	4.40	15.4	A
9	Euculyptus	California	none		7	68	lt. am.	4.04	17.8	A
10	Fall flowers	New York	none		8	111	amber	4.00	17.8	A
11	Heartsease	Unknown	none		13	55	lt. am.	3.97	17.0	Off
12	Horsemint	Unknown	none		13	45	ex. lt. am.	3.56	19.8	Off
13	Mesquite	Texas	damage	dirt**	2	38	ex. lt. am.	3.98	17.1	B
14	Orange	California	none		1	21	white	3.75	16.4	A
15	Star thistle	California	none		2	55	ex. lt. am.	3.67	16.4	A
16	Spanish needle	Unknown	none		2	80	lt. am.	4.36	18.1	A
17	Sweet clover	Unknown	damage	dirt**	1	35	ex. lt. am.	3.89	17.1	B
18	Sweet clover	Louisiana	none		2	80	lt. am.	4.10	18.1	A
19	Tupelo	Florida	none		10	57	lt. am.	3.92	18.7	Off
20	White clover	Unknown	none		1	22	white	3.77	15.8	A
21	Gardenia	Guatemula, Cen. Amer.	none		7	95	amber	4.10	18.1	A

* Imperial County, California
** Samples 13 and 17 were classed as "fairly clean."
+ lt. am.-light amber; ex. lt. am.-extra light amber.

Table 2. Grading qualities of 20 honeys from various areas within Kansas.

Sample no.	Floral source	Production area	Damage Extent	Damage Cause	rating	mm	Color grade	pH value	Per cent moisture	U. S. grade
22	Alfalfa	Langdon	none		1	33	white	3.85	17.3	A
23	Alfalfa	Turon	damage	fer.*	1	32	white	3.70	19.9	Off
24	Alfalfa	Preston	none		1	35	ex. lt. am.+	3.81	17.4	A
25	Mixed	Coolidge	damage	heat.**	4	75	lt. am.+	4.10	15.8	Off
26	Mixed	Manhattan	none		1	40	ex. lt. am.	4.00	17.2	A
27	Mixed	Cherokee	none		3	71	lt. am.	3.60	17.2	A
28	Mixed	Highland	none		1	30	white	3.72	16.5	A
29	Fall flowers	Kansas City	none		3	70	lt. am.	4.00	18.3	A
30	Heartsease	Highland	none		9	75	lt. am.	3.90	17.4	Off
31	Heartsease	Smith Center	none		15	100	amber	4.40	18.0	Off
32	Spanish needle	Cherokee	none		4	75	lt. am.	3.65	17.4	A
33	Spanish needle	Cherokee	none		3	84	lt. am.	3.70	17.7	A
34	Sweet clover	Severy	none		1	25	white	3.85	17.4	A
35	Sweet clover	Highland	none		1	28	white	3.70	17.2	A
36	Sweet clover	Cherokee	none		3	60	lt. am.	3.79	18.4	A
37	Sweet clover	Augusta	none		1	10	ex. white +	3.71	16.0	A
38	Sweet clover	Chanute	none		1	30	white	3.70	17.2	A
39	Yellow sweet clover	Smith Center	none		1	26	white	3.70	17.4	A
40	Yellow sweet clover	Manhattan	none		1	25	white	3.71	16.7	A
41	Yellow sweet clover	Chanute	none		1	10	ex. white	3.70	18.4	A

* Damaged by fermentation.
** Damaged by overheating.
\+ lt. am.-light amber; ex. lt. am.-extra light amber; ex. white-extra white.

Table 3. Comparison of grading qualities of Kansas honeys to the grading qualities of honeys produced in other areas.

Grading factors	Kansas honeys	Honeys from other areas
Color	Per cent	Per cent
Extra white	10.00	00.00
White	40.00	19.04
Extra light amber	10.00	33.32
Light amber	35.00	33.32
Amber	5.00	9.52
Dark	0.00	4.76
Flavor	Per cent	Per cent
Rating 1 to 4 or A	90.00	66.64
Rating 5 to 8 or B	00.00	14.28
Rating 9 to 12 or C	5.00	4.76
Rating 12 to 16 or D	5.00	14.28
Acidity	pH value	pH value
High	3.60	3.56
Low	4.40	4.40
Average	3.81	3.95
Cleanliness	Per cent	Per cent
Clean	100.00	90.50
Fairly clean	00.00	9.50
Dirty	00.00	0.00
Damage	Per cent	Per cent
Overheating	5.00	0.00
Fermentation	5.00	0.00
Other damage	0.00	0.00
Moisture content	Per cent	Per cent
High	19.90	19.90
Low	15.80	15.10
Average	18.05	17.44

Table 4. Comparison of various methods of determining moisture content of honeys used in this analysis.

Sample no.	Hydrometer method: specific gravity 68° F.	Hydrometer method: weight per gal. lbs.	Hydrometer method: weight per gal. ozs.	Hydrometer method: moisture per cent	Weighing known volume: weight per gill gr.	Weighing known volume: moisture per cent	Refract.* solids content per cent
1	1.4284	11	14	16.4	168.34	15.9--16.4	82.1
2	1.4235	11	13½	17.0	168.00	16.5--17.0	81.4
3	1.4372	11	15	15.1	169.21	14.9--15.4	83.3
4	1.4350	11	15	15.4	169.30	14.9--15.4	83.1
5	1.4210	11	13	17.4	167.45	17.1--17.4	81.2
6	1.4054	11	10½	19.7	165.70	19.7--20.2	80.5
7	1.4270	11	13½	16.5	168.10	16.5--17.0	81.9
8	1.4353	11	15	15.4	169.35	14.9--15.4	83.2
9	1.4184	11	12½	17.8	167.10	17.5--18.0	80.7
10	1.4190	11	12½	17.8	167.09	17.5--18.0	87.7
11	1.4240	11	13½	17.0	168.10	16.5--16.8	81.4
12	1.4045	11	11	19.8	165.72	19.7--20.2	78.8
13	1.4230	11	13	17.1	167.50	17.1--17.4	81.4
14	1.4285	11	14	16.4	168.35	15.9--16.4	81.1
15	1.4280	11	14	16.4	168.45	15.9--16.4	82.0
16	1.4164	11	12	18.1	166.66	18.1--18.4	80.5
17	1.4232	11	13	17.1	167.40	17.1--17.4	81.4
18	1.4164	11	12	18.1	167.14	17.5--18.0	80.5
19	1.4120	11	11½	18.7	166.54	18.7--19.0	81.7
20	1.4325	11	14½	15.8	178.98	15.5--15.8	82.6
21	1.4162	11	12	18.1	167.10	18.1--18.6	80.5
22	1.4231	11	13	17.3	167.45	17.1--17.4	82.1
23	1.4040	11	10½	19.9	165.35	19.7--20.2	78.7
24	1.4211	11	13	17.4	167.47	17.0--17.4	81.2
25	1.4323	11	14½	15.8	168.88	15.5--15.8	82.7
26	1.4224	11	13	17.2	167.35	17.1--17.4	81.4
27	1.4225	11	13	17.2	167.40	17.1--17.4	81.5
28	1.4272	11	13½	16.5	168.09	16.5--16.8	81.9
29	1.4165	11	12	18.3	166.78	18.1--18.6	80.3
30	1.4212	11	13	17.4	167.50	17.1--17.4	81.1
31	1.4171	11	12½	18.0	167.11	17.5--18.0	80.6
32	1.4214	11	13	17.4	167.47	17.0--17.4	81.2
33	1.4190	11	12½	17.7	167.11	17.5--18.0	80.9
34	1.4212	11	13	17.4	167.47	17.1--17.4	81.2
35	1.4222	11	13	17.2	167.50	17.1--17.4	81.4
36	1.4140	11	12	18.4	166.78	18.1--18.6	80.4
37	1.4312	11	14	16.0	168.80	15.9--16.4	82.6
38	1.4226	11	13	17.2	167.80	17.1--17.4	81.2
39	1.4214	11	13	17.4	167.39	17.1--17.4	81.3
40	1.4149	11	12	18.3	166.85	18.1--18.4	80.3
41	1.4240	11	13½	17.0	168.18	16.5--16.8	81.1

*Bausch & Lomb refractometer

by the hydrometer and from this the weight per gallon and moisture content were determined by means of a Chataway table. The weight per gallon was determined by weighing a known volume and from this the moisture content was determined by means of a Chataway table. The Bausch & Lomb hand refractommeter was used to determine the solid content. A comparison of these three means of determining the moisture content of each honey analyzed is given in Table 4.

DISCUSSION OF RESULTS

In most respects the honeys from Kansas compared quite favorably with those honeys produced in other areas as shown by Tables 1 and 2. Table 3 shows that of the Kansas honeys analyzed 80 per cent were U. S. Grade A, and 20 per cent were Off-grade, while of the honeys from other areas that were analyzed only 71.4 per cent were U. S. Grade A, 9.5 per cent were U. S. Grade B, and 19 per cent were Off-grade.

Kansas honeys, in general, were of a lighter color and had a milder flavor than those honeys produced in other areas. Kansas honeys also had a somewhat higher acid content as would be expected of lighter colored honeys (Table 3).

In regard to cleanliness, the Kansas honeys were found to be superior to those honeys produced in other areas. In Table 3 it is shown that all Kansas honeys examined were found to be

clean, while 9.5 per cent of the honeys from other areas were found to be fairly clean and only 90.5 per cent were found to be clean.

Honeys from areas outside Kansas were found to be superior to Kansas honey in regard to damage due to overheating and fermentation. All samples of honey from areas outside Kansas were free from damage from these causes, while five per cent of the Kansas samples suffered from overheating and five per cent suffered from fermentation (Table 3).

It was found that Kansas honeys had a somewhat higher moisture content than the honeys from other areas that were analyzed in this study. Kansas honeys analyzed were also slightly above the average moisture content of American honeys as determined by Browne (1908), and considerably higher in moisture content than California honeys as determined by Eckert and Allinger (1939), but much lower in moisture content than Indian honeys (Das and Bose, 1946).

Table 5 gives the average moisture content of Kansas honeys as compared to other honeys used in this study. Also shown in Table 5 is the average moisture content of various honeys as determined by other workers.

Table 5. Average moisture content of Kansas honeys and honeys other than those produced in Kansas as determined by this analysis, and the average moisture content of various honeys as determined by other workers.

Analysis made by	Locality	Year	No. of samples	Moisture per cent
Browne	American	1908	100	17.59
Eckert and Allinger	California	1939	96	16.50
Das and Bose	Indian	1946	61	19.19
Tilton	Kansas	1950	20	18.05
Tilton	Other than Kansas	1950	21	17.44

As all samples had been heated to a temperature of 145° F. two to four months before being received, it was impossible to make a comparison of the degree of granulation. However, when the honey and water mixtures were filtered through 86 meshes per inch bolting cloth at a temperature of 130° F., it was found that heavy deposits of a brownish, gummy residue was left on the filters. Upon microscopic examination it was determined that these particles consisted of partially dissolved dextrose crystals containing pollen and in two cases (samples 13 and 17) particles of dirt. When the sample was heated to a temperature of 160° F., then cooled to a temperature of 130° F. and passed through the filters this deposit was not found and only particles of foreign material were deposited on the filter pads.

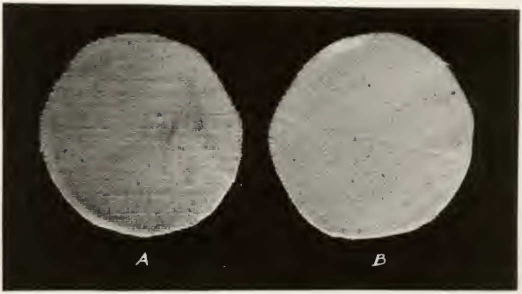

Fig. 1 A is a photograph of a filter pad as it appeared when partially dissolved dextrose particles were present in the honey filtered through it, B is a photograph of a filter pad as it appeared when the honey had been heated to a temperature of 160° F. to completely dissolve the dextrose crystals and then cooled to a temperature of 130° F.
(Enlarged 2x)

Various means of determining the moisture content of honeys were used and compared by means of a Chataway table. It was found that the use of a specific gravity spindle to determine the specific gravity and the Chataway table to determine the moisture content and weight per gallon was the most accurate of the methods used. It is also possible to weigh a known volume of honey and determine the moisture content by means of the Chataway table. However, this method was subject to many sources of error, particularily when only a small volume of honey was weighed as was the case in this study. The sample of honey must be kept at a constant temperature of 68° F. for 24 hours previous to the weighing, it is necessary to have the exact volume, the sample must be free of air bubbles, and the weight recorded must be exact. When the weight per gallon is determined the moisture content can be determined by means of the Chataway table, however, in most cases it cannot be determined as accurately as desired in exacting work. The reason for this is that the weights per gallon as given in the Chataway table are corrected only to the nearst 0.5 ounce per gallon, while a honey of a given weight per gallon corrected only to the nearest 0.5 ounce may vary in moisture content as much as 0.5 per cent. The Bausch and Lomb hand refractometer provided a convenient, fast method to determine the solids content of honey, however, it was not found to be as accurate as the hydrometer or weighing

known volumes. The solids content as determined by the hand refractometer was in all cases lower than the solids content as determined by the hydrometer.

CONCLUSION

The 20 samples of Kansas honeys examined were in most respect equal to or superior to the 20 honey samples produced in the United States in areas other than Kansas and the one sample from Guatemula. They excelled honeys from other areas in color and flavor. The average acidity (pH 3.81) of Kansas honeys was somewhat higher than the average acidity (pH 3.95) of other honeys. Honeys of a high acid content are generally of a lighter color.

Kansas honeys were superior to honeys from other areas in cleanliness. All Kansas honeys were found to be clean, while only 90.5 per cent of the honeys from other areas were found to be clean and 9.5 per cent were found to be fairly clean.

One sample of the 20 Kansas honeys had been damaged materially by overheating. This could have been prevented by proper processing by the producer and packer in carefully regulating any heat used in processing.

Another sample of Kansas honey had been materially damaged by fermentation. As it is known that honey with a high moisture content tends to ferment rapidly, it should be noted

that the water content of this sample was 19.9 per cent and was the highest of any of the honeys analyzed.

The average moisture content of Kansas honeys was 18.05 per cent while the average moisture content of honeys other than those produced in Kansas was 17.44 per cent. Root et al. (1948) states that honey is usually not fully ripened until it has a moisture content of 17.4 per cent or below. In view of this it seems evident that much Kansas honey was marketed in 1950 in which the moisture content was too high, while the average of the honeys other than those produced in Kansas had a moisture content much nearer the recommended value. Since it is known that a high moisture content in honey may be caused by excessive humidity during the ripening process (Grout et al., 1949), it is entirely possible that the humid conditions which prevailed during the nectar-flow and honey ripening period of 1950 in Kansas may have been responsible for the high moisture content of the Kansas honeys analyzed.

Despite the high average moisture content only one sample of Kansas honey had a moisture content exceeding 18.6 per cent, the limit set for U. S. Grade A or B extracted honey, while there were three samples of honeys produced in other areas which exceeded this limit.

To reduce the amount of moisture in honey and protect it from fermentation, it is recommended that only fully ripened

honey be removed from the colonies, and that in processing, heat it to 160° F., cool immediately, seal tightly and store at a cool temperature (Root et al., 1948).

SUMMARY

Twenty samples of honey from typical floral sources from various parts of the United States and one sample from Guatemala were compared with 20 samples of honey from typical floral sources from various parts of Kansas. All samples of honey were produced in 1950.

Samples were compared for color by means of the Pfund Color Grader calibrated in millimeters, which is the approved method of determining color of honey by the United States standards for grades of extracted honey. Kansas honeys ranged in color readings, from 10 to 100 millimeter. Ten per cent of the Kansas honeys were extra-white, 40 per cent were white, 10 per cent were extra light amber, and five per cent were amber. The honeys produced in areas outside Kansas ranged in color readings, from 21 to 130 millimeters. Of these honeys 19.04 per cent were white, 33.32 per cent were extra light amber, 33.32 per cent were light amber, 9.52 per cent were amber, and 4.76 per cent were dark.

Flavor of the various honeys were compared by means of a scoring standard developed by Dodge in 1929. By the use of this scoring standard it is possible to rate honeys without personal preference for the flavor of certain honeys being a factor. By

means of this scoring standard it was determined that 90 per cent of the Kansas honeys analyzed were flavor grade A, five per cent were flavor grade C, and five per cent were flavor grade D. Of the honeys from areas other than Kansas 66.64 per cent were flavor grade A, 14.28 per cent were flavor grade B, 4.76 per cent were flavor grade C, and 14.28 per cent were flavor grade D. Honeys that received a flavor grade of C or D were considered to have an objectionable flavor.

All samples were examined for turbidity and found to be clear. Five per cent of the samples of honey from Kansas had been damaged by fermentation and five per cent had been damaged by overheating. None of the samples of honeys produced outside of Kansas had been damaged.

All Kansas honeys were found to be clean, 90.5 per cent of the honeys from areas outside Kansas were found to be clean, and 9.5 per cent were found to be fairly clean. None of the honeys analyzed were classed as dirty.

Acidity was determined by means of a Beckman pH meter with temperature corrections and was expressed in pH value. Kansas honeys ranged in acidity from pH values of 4.40 to 3.60 with the average of 3.81. Honeys produced in areas other than Kansas ranged in acidity from pH values of 4.40 to 3.56 with an average of 3.95.

Weight per gallon and moisture content were determined by three methods--hydrometer test, weighing a known volume, and by a Bausch and Lomb hand refractometer. Results of the three

methods were compared by means of a Chataway table. It was found that the hydrometer test was the most accurate of the three methods, although the results of all three methods were reasonably correlated. As determined by the hydrometer, Kansas honeys ranged in moisture content from 15.8 per cent to 19.9 per cent and the average was 18.05 per cent. Five per cent of the Kansas honeys exceeded the legal limit for moisture content (18.6) for U. S. Grade A or B extracted honey. The honeys from areas other than Kansas ranged in moisture content from 15.1 per cent to 19.8 per cent and the average was 17.44. The legal limit for moisture content (18.6) for U. S. Grade A or B extracted honey was exceeded by 14.28 per cent.

As all samples had been heated to a temperature of 145° F. two to four months before this analysis was made, it was impossible to make a comparison of the degree of granulation. However, when the honey and water mixtures were passed through filters of 86 meshes per inch at a temperature of 130° F. it was found that heavy deposits of a brownish, gummy residue was left on the filters. Upon microscopic examination it was determined that these particles consisted of partially dissolved dextrose crystals containing pollen and in two cases particles of dirt. When the sample was heated to a temperature of 160° F., then cooled to a temperature of 130° F. and filtered, this deposit was not found and only particles of foreign material were found deposited on the filter pads.

Kansas honeys produced in 1950 examined were found to be superior to honeys from other areas in color, flavor, and cleanliness. These Kansas honeys also had a higher acid content which is considered a desirable characteristic. These Kansas honeys were inferior to the honeys from other areas in regard to moisture content and damage caused by fermentation and overheating.

According to U. S. grades for extracted honey it was found that Kansas honeys graded somewhat higher than honeys from areas other than Kansas. Eighty per cent of Kansas honeys were U. S. Grade A and 20 per cent graded Off-grade as compared to 71.4 per cent U. S. Grade A, 9.5 per cent U. S. Grade B, and 19 per cent Off-grade for honeys from other areas.

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GRADING CHARACTERISTICS OF KANSAS HONEYS

by

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AN ABSTRACT OF

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